POSITIONING DEVICE FOR AN X-RAY DETECTOR

RELATED APPLICATIONS

BACKGROUND

FIELD

[0001] The invention relates to a positioning device for an X- ray detector.

RELATED ART

[0002] X-ray machines serve to take X-ray images, by means of an X-ray detector and an X-ray source. They are used for instance in medical diagnosis, where bodies or body parts of patients are X-rayed in various positions and from various directions. For positioning the patient, among other possibilities patient-supporting tables are used, on which the patient can lie or sit or can place the body part to be examined.

[0003] In X-ray machines with patient-supporting tables, the X-ray detector is usually located under the tabletop itself, while an X-ray source X-rays the patient from above. A corresponding arrangement of X-ray sources and an X-ray detector can be achieved by using a so-called C-arm, for instance, which carries them on its diametrically opposed ends. It can also be achieved by means of a separate disposition of the X-ray detector in the patient-supporting table and of the X-ray source on a free-standing tripod or a tripod secured to the ceiling of the room.

[0004] To make different radioscopy directions possible, the X-ray source may be movably supported on a tripod in all directions in space, while on a C-arm, it is fixedly located and is movable solely by moving the C-arm itself. The X-ray detector, conversely, is located on a C-arm, automatically always diametrically opposite the X-ray source, while it is movable only to a limited extent as the patient-supporting device is being moved toward it.

[0005] Depending on where the X-ray machine is used, the freest possible adjustability of the radioscopy direction may be desired, for instance in radiation

monitoring of interventional procedures in surgery or interventional cardiology. The radioscopy direction must be adjustable such that the various surgical steps are made optimally visible in the X-ray projection. At the same time, precisely in interventional use, the freest possible accessibility of the patient-supporting table and the patient lying on it is of particular significance. C-arm X-ray machines are therefore often used. While C-arm X-ray machines are extremely flexibly positionable (capable of various positions) and have advantages because of the particularly flexible (capable of various positions) capabilities of orientation, at the same time because of the C-arm they are relatively bulky and hinder access to the patient to a not inconsiderable extent. ThC-armis limits the possibilities for using C-arm equipment.

[0006] From European Patent Disclosure EP 1 129 664, a patient-supporting table with a flexibly positionable X-ray detector is known. The X-ray detector is supported longitudinally displaceably under the tabletop of the device. It is also pivotable out of the device transversely to the longitudinal direction and can be tilted there in such a way that it is oriented perpendicular to the tabletop. When this patient-supporting device is used in combination with an X- ray source that is freely movable in all directions in space, various radioscopy directions can be flexibly set (adjusted), and the accessibility of a patient lying on the tabletop is not restricted by a C-arm. However, the variation of the radioscopy directions is not continuously adjustable in the same way as with a C-arm machine. A surgeon must therefore accustom himself to the handling of the device and the X-ray images that can be made using the device.

SUMMARY

[0007] The object of the invention is to disclose a positioning device for an X-ray detector which simultaneously assures as flexible (various positions) as possible a continuous adjustment of the radioscopy direction and the freest possible accessibility to a patient to be examined.

[0008] The invention attains this object by means of a device having the characteristics of the independent claim.

[0009] It is a fundamental concept of the invention to disclose a positioning device for an X-ray detector or an X- ray source that has an arched arm, in which the X-ray detector or X-ray source is supported displaceably in the direction of the arch, and that has a base in which the arched arm is supported displaceably in the direction of the arch. The use of an arched arm enables the flexible adjustability (capable of various positions) of the radioscopy direction in the same way as would be done with a C-arm. For the surgeon, this has the advantage that he can use continuously adjustable radii of motion and radioscopy angles in the way that is familiar and customary to him.

[0010] The movability of the X-ray detector or the X-ray source on the arched arm, however, simultaneously increases its range of motion in comparison with a C-arm, on which the X-ray detector and the X-ray source are secured nondisplaceably. As a result, to make a comparable range of motion possible, the arm can be reduced to half the length, compared to a C-arm arm. This reduces its bulk, and there is less hindrance to access to the patient-supporting device. Last but not least, the displaceability on a circular path, in cooperation with an X-ray source or X-ray detector located separately from the positioning device and displaceable on a contrarily extending circular path, makes it possible to create images of slices or three-dimensional images of the body to be examined. Such images of the body have been made until now under comparable conditions using C-arm X-ray machines, whose image data are processed into three- dimensional images by analogy with computed tomography image data. The prerequisite for this is the motion along a circular path whose center point is located in the body region to be examined.

[0011] In an advantageous feature of the invention, the arched arm is supported displaceably in the direction of the arch in a second arched arm, and the second arched arm is supported in the base displaceably in the direction of the arch. By the use of a second displaceable arm, the range of motion of the X-ray detector can be doubled, without having to increase the length of each individual arched arm substantially. Thus a greater range of motion is attained while the bulk of the

positioning device remains the same, and the accessibility to the patient-supporting device is not additionally hindered.

[0012] In a further advantageous feature of the invention, the X-ray detector or the X-ray source can be supported movably in the arched arm in the radial direction relative to the arch. As a result, the X-ray detector or the X-ray source can as needed be brought closer to a patient positioned in the center of the arch. This is especially advantageous if the positioning device is located under the patient-supporting table. If an X-ray detector is supported in the positioning device, it can be brought from below toward the patient- supporting table, so that an X-ray can be made with a vertical angle of incidence of the X-radiation. In this arrangement, X-ray images can be made of the kind that are possible with conventional X-ray machines with an X-ray detector under the table, known as Bucky systems. This expands the possibilities for using the X-ray machine.

[0013] In a further advantageous feature of the invention, the positioning device is used in an X-ray machine with a patient-supporting device, and the X-ray machine has an X-ray source that is movably supported in all directions in space and is located separately from the positioning device. This configuration, because of the separate disposition of the X- ray source, makes especially free accessibility to the patient-supporting table possible, since the positioning device does not substantially restrict accessibility, and regardless of this the X-ray source can be positioned so as to present little hindrance as possible. At the same time, because of the free movability of the X-ray source, arbitrary angles of incidence can be set (adjusted). The X-ray source can for instance be supported from a ceiling-mounted tripod, where essentially only from above can it restrict accessibility to the patient-supporting table.

[0014] In a further advantageous feature of the invention, the X-ray machine has a control unit, which is connected to the X-ray source and the positioning device and is embodied so as to move the X-ray source and the positioning device in a manner adapted to one another, so that they assume a predetermined orientation to one another. The orientation to one another can be selected such that the X-ray detector is at all times located in the X-ray beam of the X-ray source and

perpendicular to it. This orientation makes it possible to create an X-ray image at all times, without a machine operator having to manually adjust the various individual positions exactly. Instead, it suffices if the X-ray source is aimed by a machine operator in a desired way, for instance, while the X-ray detector is made to automatically follow its motion by means of the control unit. Maintaining the orientation by means of the control unit can also be used to make three-dimensional or slice images of the body to be examined, in which the X-ray source and the X-ray detector must be moved along a circular path, diametrically opposite one another.

DRAWINGS

[0015] Further advantageous features of the invention will become apparent from the dependent claims.

Exemplary embodiments of the invention are described in further detail below in conjunction with drawings. Shown are:

[0016] Fig. 1, a positioning device with an X-ray detector and a patient-supporting device;

[0017] Fig. 2, the positioning device in a different position of the X-ray detector;

[0018] Fig. 3, an X-ray machine with a positioning device; and

[0019] Fig. 4, an X-ray machine with a positioning device and a control unit.

DESCRIPTION

[0020] In Fig. 1, one embodiment of the positioning device 1 is shown along with a patient-supporting device. The patient- supporting device comprises a patient-supporting table 5, which is secured to a table pedestal 7.

[0021] The positioning device 1 is located under the patient- supporting table 5. It has a base 9, by means of which it is supported either on the patient-supporting device or on the floor.

[0022] An arched arm 15 is supported in the base 9 via a second arched arm 13. An X-ray detector 11 is supported on the arm 15 by means of a mounting device 17.

[0023] The mounting device 17 is movably supported in the arm 15 such that the X-ray detector 11 is displaceable along the arm 15 in the direction of the arch. The X-ray detector 11 is located in the drawing in a position in which, compared to its outset position, it is deflected maximally counterclockwise. From there, it can now be displaced only clockwise, which is represented in the drawing by an arrow pointing clockwise. In this direction, it can be displaced as far as the diametrically opposed maximally deflected position, without being hindered by other device elements, such as an X-ray source, since it is the only part of the device that is supported on the arm 15.

[0024] The arched arm 15 is supported in the second arched arm 13 displaceably in the direction of the arch. It is likewise located in a position that is maximally deflected counterclockwise. The arm 15 can likewise be displaced from there only in the clockwise direction, which is represented by a corresponding arrow in the drawing.

[0025] The second arched arm 13 is in turn supported in the base 9 displaceably in the direction of the arch. However, in contrast to the X-ray detector 11 and the arm 15, it is not located in a maximally deflected position and is therefore displaceable both clockwise and counterclockwise, which is also represented by corresponding arrows in the drawing.

[0026] The deflection of the X-ray detector 11, which is supported in the positioning device 1, can be adjusted, in a first embodiment, by manual displacement done by a machine operator. Bearing and locking mechanisms, not shown in the drawing, assure the free movability and fixability in the desired deflection. In a further embodiment, the deflection of the X-ray detector 11 can be motor-adjusted by means of the positioning device 1. In this embodiment, drive motors, not shown, automatically displace the arms 13, 15 and the mounting device 17 outward.

[0027] In Fig. 2, the same positioning device 1 with a patient-supporting device 5 as in the preceding drawing is shown, and the same reference numerals are used. However, the arched arms 13, 15 and the mounting device 17 with the X-ray detector 11 are located here in their outset position symmetrically to the base 9. In this position, the positioning device 1 has minimal bulk and presents only insignificant hindrance to the accessibility to the patient table 5 to machine operators or medical professionals.

[0028] In a further embodiment of the positioning device 1, the X-ray detector 11 is supportable on the arched arm 15 in such a way that it can be moved in the radial direction relative to the arch and toward the patient table 5 in the drawing, which is represented by a vertical arrow. For this purpose, the mounting device 17, which is supported movably in the direction of the arch in the arm 15, is radially adjustable. The X-ray detector 11, which is held by the mounting device 17, can as a result be brought closer to a patient located in the center of the arch. In the embodiment shown, in which the positioning device 1 is located under the tabletop 5, an arrangement can accordingly be achieved in which the X-ray detector 11 is brought from under toward the tabletop 5, and this is represented by dashed lines in the drawing. This arrangement is similar to that for an X-ray machine in which the X-ray detector is attached immediately under the table 5 either fixedly or movably in the longitudinal direction and is exposed vertically from above, that is, a so-called Bucky system. Because of the radial movability of the X-ray detector 11, the positioning device 1 can therefore also be used as a Bucky system.

[0029] In Fig. 3, an X-ray machine 21 with a positioning device 1 is shown. The positioning device 1 has an arched arm 15 and a further arched arm 13, by way of which arms an X-ray detector 11 is supported as described above in a base 9, displaceably on a circular arc. The X-ray detector 11 is supported in the arm 15 via a supporting arm 19 and a mounting device 17. The positioning device 1 is located below a patient-supporting device, which comprises a tabletop 5 supported on a table pedestal 7. No further details of the patient-supporting device are shown in the drawing.

[0030] Located above the patient-supporting device is an X-ray source 23, which is supported in a ceiling-mounted tripod 25. The X-ray source 23 is movable in the vertical and horizontal directions, as indicated by corresponding arrows. Moreover, it is rotatable about a horizontal axis and about a vertical axis, which is also indicated by arrows. Because of the three-dimensional movability of the X-ray source 23, virtually arbitrary X-ray angles can be set.

[0031] The positioning device 1, because of its movability, on the one hand assures that the X-ray detector 11 can be oriented in such a way, in adaptation to virtually all X-ray angles, that it is oriented both in the X-ray beam and vertically to it. In particular, the X-ray detector 11 is rotatable about a vertical axis, as is indicated in the drawing by an arrow. For this purpose, it is supported rotatably on the supporting arm 19, or the supporting arm 19 is supported rotatably on the arm 15, or the arm 13 is rotatable in the base 9. The maximum settable angle of rotation depends on the construction, which is adapted to the particular use. Advantageously, it amounts to at least 20°. Because of the free movability of the X-ray source 23 and the X-ray detector 11, virtually arbitrary radioscopy angles for examining a patient, not shown, lying on the tabletop 5 can be attained.

[0032] In Fig. 4, an X-ray machine 21 with a positioning device 1 and an X-ray source 23 as well as a control unit 27 is shown in perspective. The positioning device 1 has a base 9, in which the arched arms 13, 15 and th X-ray detector 11 are supported displaceably and movably on a mounting device 19. The mode of operation of the positioning device 1 corresponds to that described in the foregoing drawings.

[0033] The X-ray source 23 is supported three-dimensionally movably on a ceiling-mounted tripod 25 and likewise, as described above, is movable in the horizontal and vertical directions and is rotatable about a horizontal and a vertical axis.

[0034] The three-dimensional movability of the X-ray source 23 and of the X-ray detector 11 make it possible to set (adjust)the most various radioscopy directions. The X-ray detector 11, for making an X-ray image, is located in the X-

ray beam of the X- ray source 23 that is represented by dashed lines in the drawing, and vertically to it.

[0035] The X-ray machine 21 ha a control unit 27, which is shown in the drawing without further details. The X-ray source 23 is connected to the control unit 27 via an electrical cord 29. As a result, both the generation of X- radiation and the motion of the X-ray source 23 in space can be controlled by the control unit 27. The positioning device 1 with the X-ray detector 11 is also connected to the control unit 27 via a cord 29. As a result, the motion of the positioning device 1 can also be controlled by the control unit 27, and image data from the X-ray detector 11 can furthermore be transmitted.

[0036] The control unit 27 has a control program, by means of which the motion of the X-ray source 23 and of the positioning device 1 can be controlled automatically. In one version, the control program is designed such that the X-ray source 23 can be oriented manually by a machine operator. From position detectors, not shown, the control unit 27 receives information about the present position of the X-ray source 23 and triggers the positioning device 1 in such a way that the X-ray detector 11 follows along with the motions of the X-ray source 23. In a further embodiment, the control program of the control unit 27 is designed such that the X- ray detector 11 and the X-ray source 23 are moved along a circular path, diametrically opposite one another, around a patient, not shown, lying on the tabletop 5. X-ray image data, recorded in various X-ray beam directions along such a circular path, can be processed to make three-dimensional images or images of slices of the body to be examined. The processing of the image data is done in a way similar to how it is done in computed tomography, or in the way such image data are processed by means of C-arm X-ray machines. The control unit 27 thus controls the X-ray source 23 and the positioning device 1 in such a way that the motion of a C-arm X-ray machine is simulated.

[0037] As the X-ray detector 11 in conjunction with the positioning device 1 described above, a digital X-ray detector can advantageously be used, such as a solid-state detector. As a result, X-ray image data are available immediately after

the images are made, which is especially advantageous in interventional medical applications.

[0038] Further embodiments of the positioning device 1 may have only one or a plurality of arched arms, with a corresponding mode of operation. Other versions of the X-ray machine 21 may for instance have a wall-mounted or floor- mounted tripod, instead of a ceiling-mounted tripod 25. A version in which the positioning device 1 is embodied such that instead of an X-ray detector it has an X-ray source, and in which the X-ray detector is instead located separately from the positioning device 1, is also possible.